	24Gy						18Gy						
	Ring5mm(Gy)			Ring10-5mm(Gy)				Ring5mm(Gy)			Ring10-5mm(Gy)		
Patient	MLCi1	Agility	Diff	MLCi1	Agility	Diff	Patient	MLCi1	Agility	Diff	MLCi1	Agility	Diff
1	12.2	10	2.2	5.6	4.6	1	6	12.4	10.9	1.5	5.5	4.7	0.8
2	12.9	10.9	2	6.3	5.3	1	7	14.6	13.8	0.8	4.5	3.8	0.7
3	11.9	10.4	1.5	5.6	4.8	0.8	8	13.5	12.3	1.2	7.6	6.2	1.4
4	19.9	17.9	2	5.4	4	1.4	9	14.5	13.8	0.7	5.2	4.6	0.6
5	16.5	15.1	1.4	8.4	7.1	1.2	10	13.3	12.9	0.4	7.2	6.7	0.5
mean	14.2	12.9	**1.8**	6.2	5.2	**1.1**	mean	13.7	12.7	**0.9**	6	5.2	**0.8**
SD	3.5	3.5	**0.3**	1.2	1.2	**0.2**	SD	0.9	1.2	**0.4**	1.3	1.2	**0.4**

Tabel 1: Mean dose in the rings around the PTV at 5 mm and 10 mm for small lesions (PTV volume < 4 cm³) and the larger lesion (PTV volume between 4 and 14 cm³)

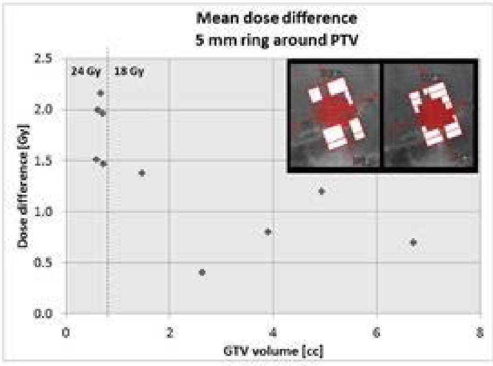

Figure 1: The mean dose difference in the first 5 mm ring around PTV. In the right upper corner the typical leaf setting for the Agility on the right and the MLCi1 on the left.

Conclusion: For the small lesions with a volume smaller than 4 cm³ the Agility shows a steeper gradient in the two surrounding rings than the MLCi1. Therefore we recommend the use of the Agility for treating the smaller lesions.

EP-1681
A treatment planning strategy for SBRT of multiple T1-2 lung tumors

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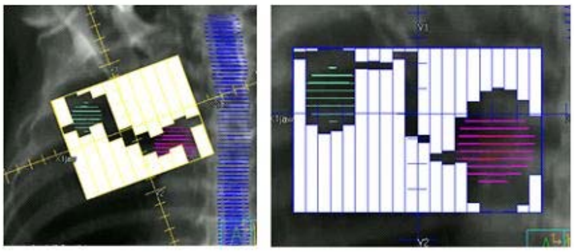
Purpose or Objective: To obtain a planning technique for SBRT treatment of multiple lung tumors, which is suitable for all relative positions of the tumors.

Material and Methods: For 10 patients with two tumors, treated with 3 x 18Gy, VMAT plans were generated in Pinnacle, using various approaches: simultaneous versus sequential optimization, with or without the dose distribution of one tumor as background for optimization of the other tumor. The quality of the treatment plans was judged on coverage (PTV V100% >95%), conformity (V100%/PTV volume), inhomogeneity (PTV D0<165%) and dose constraints on OARs.

Results: Simple addition of beams for two independently planned tumors does not yield optimal results since the mutual low dose contributions cannot be taken into account properly. Simultaneous optimization on both targets results in pairs of open leafs in-between the lesions (Fig 1). We therefore concluded that the strategy that yields the most conformal plans is the subsequent planning of the tumors using a dual-arc for both, where the dose distribution resulting from the planning of the first target is used as a background dose while optimizing the beams for the second target. During optimization of the first tumor, no limit is applied for the dose to the second PTV, since this can be compensated for in the optimization procedure for this PTV. After optimization of the second PTV, the number of monitor units in each beam pair might be adjusted slightly to conform to the required target coverage. This strategy works for two or more isocenters as well as for one mutual isocenter. For three or more tumors, iterating the above method yields good results



Two examples of simultaneous optimizing on both targets (fig1)

Conclusion: We developed a generic planning strategy to obtain high quality lung SBRT-treatment plans for patients with multiple lung tumors. The strategy uses a dual-arc VMAT for each tumor, while taking the dose distribution covering the first target is used as background during dose optimization for the second target. This method is clinically in use since March 2015, since then 15 patients have been treated using this method.

EP-1682
Breast and regional lymph nodes RT: V-MAT/RapidArc and Tomotherapy comparison

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Purpose or Objective: Two centers compared VMAT/RapidArc (RA) and Tomotherapy (TOMO). for the irradiation of breast and regional lymph nodes.

Material and Methods: Five left and five right breasts plus regional nodes have been contoured by two dedicated radiation oncologists. Two senior physicists checked the treatment plans studied by dedicated dosimetrists. The Anatom-e tool was tested for improving definition and avoiding interpersonal variability in the contouring. Prescription, according to ICRU, was 50 Gy in 25 daily fractions. We considered both lungs, the heart, the left anterior descending coronary artery (LAD), the controlateral breast and the thyroid as Organa t Risk (OaR). The dose constraints were: PTV V95=95%, ipsilateral lung V20≤20%, heart mean dose < 10Gy, heart max dose <35Gy, LAD max dose ≤20Gy, thyroid max dose < 45 Gy and contralateral breast max dose≤5 Gy. We have studied the treatments in free breathing modality, perfectly aware of the higher dose received by heart and LAD in comparison to the respiratory-gated modality, routinely used in the RA center.

Results: We summarized the results of this comparison in Table 1
Table 1. Left and right breast plus lymphnodes.

	TOMO	RA
LEFT BREAST + LN	% (±SD)	% (±SD)
V95% PTV	94.9 (±0.5)	95.1 (±10)
V20Gyipsilateral lung	15.9 (±1.3)	22.2 (±3.2)
	Median dose Gy (±SD)	Median dose Gy (±SD)
LAD	4.7 (±0.9)	15.7 (±4.5)
Heart	3.5 (±3.8)	9.0 (±1.7)
Contralateral breast	5.1 (±1.4)	4.2 (±1.1)
	Median min (±SD)	Median min (±SD)
Beam-on time	6.91min (±0.21)	1.03min (±0.03)
RIGHT BREAST + LN	% (±SD)	% (±SD)
V95 PTV	95.0 (±0.5)	94.9 (±0.1)
V20 ipsilateral lung	19.4%(±3.1)	21.2%(±1.5)
	Median dose Gy (±SD)	Median dose Gy (±SD)
LAD	2.0 Gy (±1.1)	7.7 Gy (±0.9)
Heart	5.9 Gy (±0.8)	6.8 Gy (±1.5)
Contralateral breast	3.6 Gy± (0.5)	4.2 Gy (±0.4)
	Median min (±SD)	Median min (±SD)
Beam-on time	5.9min (±0.26)	1.07min (±0.01)

Conclusion: Both techniques allow a good coverage and dose uniformity for the PTV, with proper sparing of the OaR. TOMO allows greater hearth and LAD sparing in left cases, when compared to RA with no gating. Of note beam-on time, in RA modality, is highly decreased.

EP-1683

Left breast IMRT with SIB: a user improved technique to reduce heart and lung dose

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Purpose or Objective: Many strategies have been explored in attempt to reduce the cardiac dose and the lung dose during breast irradiation. Here we investigated the efficacy of user optimised collimator rotation and jaws setting, in static gantry IMRT with simultaneous integrated boost (SIB), on hearth and lung dose sparing.

Material and Methods: From September 2010 to March 2014, 69 patients were treated for left breast (PTV-breast) cancer with SIB at surgical bed (PTV-boost) in 25 fractions: the prescribed doses (Dp) were 50 Gy and 60 Gy, respectively. All plans were generated with Varian EclipseTM v.10.0.28 TPS, using 5-7 IMRT sliding-window fields equally spaced along a 190° arc, with 6MV photon beams and a Varian Millenium120TM multileaf collimator. Dose computation were performed by AAA algorithm, with a 2.5 mm grid size. The first 41 patients were planned by fixing a null collimator rotation, and by leaving the optimizer Varian DVOTM v.10.0.28 free to search for the optimal setting of the jaws (IMRT-A). In the next 28 patients the arrangement of the two outermost tangential fields were set to maximally spare the heart and the left lung. In details, the collimator was rotated so as to align the medial jaw with the projection of the chest wall (IMRT-B). Further, for the most lateral field the jaws were collimated to the lateral and central portions only of the PTV-breast. The remaining 3-5 fields covered entire target according the BEV projection of the target. By selecting the Fixed Jaws Parameter of the two outermost fields into DVO the same jaws aperture defined in BEV were assured during optimization process. Plans aimed to cover at least 95% of the PTVs volume with a dose ³ 95% of the Dp (V95% ³95%), with V107%<2%, for PTV-boost. Hearth volume receiving more then 20 Gy (V20)<10%. Left lung V20<20%. Right breast mean dose (Dmean)<2Gy and right lung Dmean<3Gy. By hypothesis testing, several dose-volume metrics were then compared across the two groups of plans.

Results: As detailed in Table 1, although a slightly reduced V95% to PTV-breast was associated with IMRT(B), both techniques assured to any patient the required target dose coverage. In terms of dose sparing to the OARs, IMRT(B) was associated with a 25.6% reduction in the median of Dmean to the heart, while the heart V5, V10 and V20 were respectively reduced by 21.1%, 49.8%, and 52.1% (all p<0.002). Further, the median of Dmean to the left lung decreased by 21.2%, while V5, V10 and V20 to this organ decreased by 5.4%, 36.8% and 28.6%, respectively (all p<0.003). No significant differences resulted for Dmean to the right breast and lung.

Table 1 Comparison of median (range) values of dose-volume metrics for PTV coverage and OAR sparing as a function of IMRT plan modality

		IMRT-A	IMRT-B	*p-value*	
PTV-breast	V95% (%)	97.6 (94.5-99.9)	96.5 (93.8-99.1)	*0.003*	§
PTV-boost	V95% (%)	99.8 (97.9-100.0)	99.8 (98.0-100.0)	*0.408*	#
	V107% (%)	1.6 (0.0-15.1)	0.1 (0.0-13.0)	*0.057*	#
Hearth	Dmean (Gy)	9.4 (5.0-16.6)	7.0 (4.1-13.0)	*<0.001*	$
	V5Gy (%)	71.8 (41.5-97.8)	56.6 (25.7-98.4)	*0.002*	$
	V10Gy (%)	33.9 (7.1-75.7)	17.0 (2.2-62.4)	*<0.001*	*
	V20Gy (%)	7.5 (0.3-32.9)	3.6 (0.0-11.8)	*0.001*	*
Left lung	Dmean (Gy)	14.6 (10.6-19.9)	11.5 (7.6-19.1)	*<0.001*	*
	V5Gy (%)	91.2 (72.9-100)	86.3 (51.1-99.8)	*0.003*	*
	V10Gy (%)	54.4 (29.7-89.2)	34.4 (22.4-90)	*0.0002*	*
	V20Gy (%)	21 (12.4-45.3)	15 (6.2-30.2)	*<0.001*	*
Right breast	Dmean (Gy)	1.7 (0-4.2)	1.4 (0.7-6.6)	*0.493*	#
Right lung	Dmean (Gy)	2.2 (1.1-4.9)	1.5 (0-6.7)	*0.209*	#

Abbreviations: § two-tailed t-Student test, # two-tailed Mann-Whitney test, $ one-tailed t-Student test, * one-tailed Mann-Whitney test.

Conclusion: Similar PTVs coverage were obtained with both IMRT techniques, the selection from an experienced user of collimator rotation and fixed jaws settings for the two outermost tangential fields in a 5-7 fields sliding-window IMRT (IMRT-B) resulted in a significant reduction of the dose to the heart and the ipsilateral lung.

EP-1684

Optimization of a VMAT technique for three dose level irradiation of head and neck cancer

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Purpose or Objective: It was reported in literature that increasing the number of arcs from 1 to 4-8 improves the quality of head and neck (HN) VMAT plans with simultaneously integrated boost (SIB). Aim of this work is to optimize the performance of triple-arc VMAT (TAV) against conventional IMRT for three dose level irradiation of advanced HN cancer.

Material and Methods: A retrospective planning study was conducted on a sample of 10 patients with HN cancer previously treated with IMRT. PTVs were delineated for 3 different dose levels (70, 63 and 56 Gy in 35 fractions) delivered by a SIB technique. All plans were generated with 6 MV x-rays for a Varian Clinac iX linac. Optimization and calculations were done in the Varian Eclipse system (v. 10.0.28). IMRT plans included 7 equally placed beams using sliding window technique. Three TAV plans were generated for each patient: triple full-arc plan, 3F (collimator angles (CA): 0°, 20°, 340°); double full + partial arc plan, 2FP0 (CA: 20°, 340°; 0° for partial arc); double full + partial arc plan, 2FP90 (CA: 20°, 340°; 90° for partial arc). Dose normalization was set as D(95%)=70 Gy for the primary tumour and involved nodes (PTV70), while planning objectives were D(95%)≥ 95% of prescription dose for the high- and low-risk target volumes (PTV63 and PTV 56). OARs taken into account into optimization included the brainstem, spinal cord, parotids, oral mucosa, larynx, mandible, vertebrae, thyroid. The healthy tissue was defined as the body volume excluding the PTVs. Planning objectives are shown in Table 1. The parameters used for plan comparison include PTV coverage, dose homogeneity (HI) and conformity (CI), OAR sparing, healthy tissue integral dose (HTID) and number of MUs.

Results: Table 1 shows the results of PTV coverage, homogeneity, conformity, and doses to OARs for the 4 planning techniques. Similar coverage of all PTV's is obtained in all the techniques. TAV plans show better homogeneity and conformity in PTV70 compared to IMRT, though the difference is significant only for HI of the 2FP90 technique. For spinal cord and vertebrae the 2FP90 plans show significant reductions of maximum dose. No significant